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Mental health and academic achievement of Finnish university students according to their diet types

Ansung Kim
Master's thesis University of Helsinki
Faculty of Agriculture and Forestry
Master's Programme of Human
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Author Ansung Kim		
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Abstract

Understanding the relationship between plant-based diets and mental health has become an important issue from a public health perspective, not only for researchers but also in everyday life. In particular, this study focused on university students since more and more students have been limiting their animal-based foods intake. At the same time, there has been a global trend of increasing mental disorders and distress among university students. Poor mental health conditions, such as depression and anxiety, could associate with students' academic achievement. This study examined the connections between diet choice, mental health, and academic achievement.

This study used cross-sectional data from the Student Health Survey 2016 by the Finnish Student Health Service (FSHS). Among 3029 participants (aged 18 to 35 years) from either academic universities or universities of applied sciences in Finland, the questions from the Index of Diet Quality (IDQ) were used to construct four different diet types: 67 vegans (2.2%), 281 vegetarians (9.3%), 291 semi-vegetarians (9.6%), and 2390 omnivores (78.9%). Mental health status was measured by using two indicators: self-reported diagnosed mental disorders (depression and/or anxiety) and the General Health Questionnaire-12 (GHQ-12), which screened minor psychiatric disorders. Academic achievement was measured by asking about perceived academic success. The logistic regression models were used in the main analyses. The two different mental health status were analysed with adjustment for potential confounding variables such as sociodemographic factors, health-related behaviour, BMI, and disease conditions. The academic achievement was analysed with adjustment for potential confounding variables such as sociodemographic factors, health-related behaviour, BMI, disease conditions, enrolment period, and right field of study. Also, this study further examined the association between food groups and academic achievement.

The results showed that compared to the omnivorous diet, the vegetarian diet was associated with higher odds of diagnosed mental disorders (OR [95% CI]: 2.74 [1.80–4.16], $p<0.001$) and minor psychiatric disorders screened by GHQ-12 (OR [95% CI]: 1.68[1.22–2.30], $p<0.001$) after adjustment for all potential confounders. Although a positive relationship between fish consumption and academic achievement was found (OR [95% CI]: .88[.80–.96], $p<0.01$), there was no statistically significant association between diet types and academic achievement. In addition, higher sweets consumption was related to higher odds of being less successful than students had expected (OR [95% CI]: 1.08 [1.01–1.15], $p<0.05$).

The results indicate that vegetarian university students are more likely to have lower mental health status than non-vegetarian students on average. In addition, academic achievement is associated with the consumption of specific food items rather than diet types. Overall, the findings suggest that vegetarian students should carefully monitor their mental health status. Also, students should be supported to improve their food choice and dietary quality for their academic achievement. The study results can be implicated in public health interventions to improve students' well-being among higher education students. In future research, it may be beneficial to apply more various classifications and measures of diet types and academic achievement and examine the temporal relationship between diagnosed mental disorders and the diet chosen.

Keywords
plant-based diet, vegetarian, vegan, depression, mental disorders, academic achievement

Supervisor or supervisors
Hanna Konttinen

Where deposited
HELDA - Digital Repository of the University of Helsinki
FSD - Finnish Social Science Data Archive

NOTE

Writing this master's thesis has been a challenge since the COVID-19 pandemic have completely changed our everyday life. There were difficulties in finding data that fit the purpose of this thesis.

I wish to sincerely thank my supervisor Dr. Hanna Konttinen, who has guided me through this master's thesis process. She has not only given valuable feedback but also encouraged me to finish this thesis. I also wish to thank the Finnish Social Science Data Archive (FSD) for providing me with the data and translation.

The original data I used in this master's thesis was collected from the University Student Health Survey 2016, which conducted by the Finnish Student Health Service (FSHS) to examine the health and health-related behaviour of university and university of applied sciences students in Finland.

There were 548 variables in the raw data. Based on the purpose of this thesis, I selected 52 variables, including socio-demographic characteristics (age, gender, location, and institution), diagnosed mental disorders (depression and anxiety), the General Health Questionnaire-12 (GHQ-12), food frequency, health-related questions (diagnosed disease condition, participant's height and weight, physical activity, smoking habit, and alcohol consumption). After then, I treated data for the purpose of analyses. For example, I classified participants by diet types (i.e., vegan, vegetarian, semi-vegetarian, and omnivore) based on the food frequency questions in raw data, and screened participants' mental health status through questions based on GHQ-12 and had to change the original code according to scoring method during this process. Furthermore, I calculated the Body mass index (BMI) based on the raw data, and I combined questions to make a binary variable for the analyses. The data analyses were conducted using various statistical methods, from a chi-square test to logistic regression analysis. Based on previous literature, I selected potential confounders and constructed logistic regression models to derive results.

This thesis deposited in the Digital Repository of the University of Helsinki (HELDA) and the Finnish Social Science Data Archive (FSD)

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1. INTRODUCTION

There has been growing attention on how we eat and what we eat. We eat food not only as fuel for our body, but we also eat food because of the meaning behind it (Mason & Lang, 2017). It can be our thought, desire, identity, or culture (Fiddes, 1991). Food represents our sense of identity (Fischler, 1988), ethical and spiritual concerns (Ruby, 2012), and political actions (e.g., Concern about animal welfare, environmental; Kalte, 2020). At the same time, people have been concerning to limit their meat intake and increasing fruit and vegetable intake for health, ethical consideration, environmental impacts, and other reasons (De Backer & Hudders, 2014). Vegetarian diets have been widely considered as one of the healthier diet options since it is known to have beneficial health effects by preventing, for example, chronic diseases, cardiovascular disease, obesity, type 2 diabetes, and high blood pressure (Craig, 2009; Craig & Mangels, 2009; Le & Sabaté, 2014; Leitzmann, 2014). On the contrary, it is widely known that diets high in red and processed meat have unhealthy effects on such disease (Chen, Lv, Pang, & Liu, 2013; Clark, Springmann, Hill, & Tilman, 2019; Feskens, Sluik, & Woudenbergh, 2013). It has also been claimed that red meat is one of the most responsible food factors for environmental impacts such as acidification, greenhouse gasses (GHGs) emissions, and land use (Clark et al., 2019). A recent report from the Lancet commission showed that the world population's meat and dairy consumption had exceeded their daily food intake recommendation (Willett, 2019). The report suggested that reducing meat consumption is beneficial for both healthy diets and sustainable food systems.

Although it seems relatively clear that meat intake should be reduced, it is also a well-known important source of various nutrients. Thus, a question arises here: what is the effect of restricting animal-based food consumption on people's health? Many studies are addressing this question, but in particular, evidence on mental health is very controversial. Recently, Dobersek et al. (2020) conducted a systematic review of the literature which studied the relationship between plant-based diets and mental health. They showed that eleven out of 18 studies supported that people who eat plant-based meals were more likely to have adverse mental health problems, such as depression, anxiety, and self-harm, compared to those who do not. Four of the 18 studies could not find a difference between meat abstainers and non-meat abstainers or complexed results. The remaining three studies have shown that people who eat meat were more mentally vulnerable (Dobersek et al., 2020).

Furthermore, another systematic review showed a relationship between plant-based diets and poor mental health status. In particular, it suggested that young people (under 26 years of age) have shown more vulnerable mental health compared to the older age group (aged 26 to 45), based on the anxiety score and stress levels (Iguacel, Huybrechts, Moreno, & Michels, 2020). There is a potential risk posed by the complete exclusion or restriction of animal-based food, apart from the clear health benefits of reducing meat and increasing vegetables and fruits intake. In addition, it is particularly important to study the connection between diet and mental health status among the young population such as university students, since individuals who are young, living in urban areas, and highly educated were more likely to be interested in meat-free diets and to consume plant-based food products (Jallinoja, Niva, & Latvala, 2016). Jallinoja (2020) observed a rising trend in the meat-free diet among the young population, especially among the women in Finland. Moreover, mental disorders were shown an increasing trend among university students in globally (Oksanen, Laimi, Björklund, Löyttyniemi, & Kunttu, 2017; Sarokhani et al., 2013; Schofield, O'Halloran, McLean, Forrester-Knauss, & Paxton, 2016). In Finland, Oksanen et al. (2017) found there was an upward tendency of mental distress among Finnish university students.

University life is a unique period due to the tremendous changes that university students experience (Arnett, 2000). Along with this, students often formed new behaviours in this period (Nelson et al., 2008). The habits developed during university time can last long and play a significant role in the quality of life since the habits have settled down autonomously with identity formation (Crombie, Ilich, Dutton, Panton, & Abood, 2009). Especially while adjusting to the unfamiliar environment, it can be a huge burden for students to change habits, get good grades, and plan for the future. It can cause stress and make students suffer from depression (Sarokhani et al., 2013). Along with these environmental changes, students build aspects of internal identities, such as the meaning of life, considering their role in the world, and shake off identities that do not suit them. However, this process can cause or worsen anxiety (Iarovici, 2014). Therefore, university students are at risk for adverse mental health states, such as depression and anxiety. At the same time, they are more likely to be interested in plant-based diets, which could be related to poorer mental health, and this condition might be associated with their academic achievements.

In this study, the association between mental health status and diet types and the association between diet types and academic achievement among Finnish higher education students have been

investigated. Specifically, the present study first examined whether different diet types link to mental health status. Then, whether different diet types have a relationship with academic achievement were examined. The mental health status was examined by clinically diagnosed mental disorders (depression and anxiety symptom) and the General Health Questionnaire-12 (GHQ-12), and the diet types were categorised into four different types: vegan, vegetarian, semi-vegetarian, and omnivore. The academic achievement was estimated by a perception of successfulness in participants' study. The data is from the nationwide Student Health Survey 2016, conducted by the Finnish Student Health Service (FSHS). The survey population was representative of higher education students in Finland.

Overall, this study aimed to find the connection between university students' dietary choice, their mental health, and their academic achievement so that it could help to build healthy dietary habits and improve the quality of life for university students.

2. LITERATIRE REVIEW

2.1. Why do people follow plant-based diets?

Eating meat has been a very natural habit, and it has been widely selected in particular social ceremonies (Fiddes, 1991). Meat is rich in nutrients such as protein, vitamins, and minerals, and it has been culturally symbolized as a healthy source and human power (Beardsworth & Bryman, 2004; Simoons, 1994). Paradoxically, however, meat has also been famous for being avoided, tabooed, and regulated for religious reasons, impurity about animals, and human custom (Simoons, 1994). Vegetarianism has existed in the Middle Ages, even in ancient times, and in many cultures around the world. For example, India, where a meat-free attitude has continued through religions, China where the traditionally consume little or no animal-based food in the diet, and the Near East and Mediterranean area where vegetarian attitude observed among some clergy and laity (Simoons, 1994). The interest in vegetarianism has begun to grow in modern times with concerns about health problems and the environment along with animal rights.

Vegetarianism has been adapted more flexibly and suggested several ways of following the diets. It might be since people tend to follow plant-based diets gradually while they call themselves vegetarian (Beardsworth & Keil, 1992). The stage of plant-based diets can be changed by limiting specific food categories according to their motivation, social circumstance, and knowledge of nutrition. Therefore, people move back-and-forth on their diets between more rigorous restrictions and less rigorous restrictions (See Figure 1) (Beardsworth & Keil, 1992).

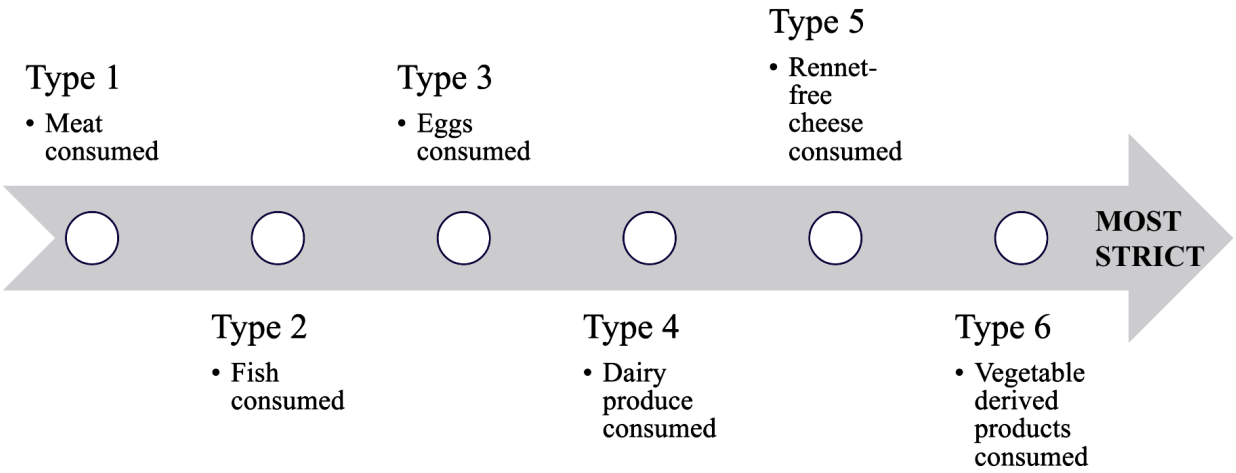

Figure 1. A typology of forms of vegetarianism (Beardsworth & Keil, 1992)

Santos & Booth (1996) reported an attitude of avoiding meat among undergraduate students. They observed a gradual pattern of meat avoidance among those who choose a vegetarian dish. Red meat (e.g., beef or lamb) was the foremost commonly abstained, followed by white meat (e.g., chicken or turkey) (Santos & Booth, 1996). Likewise, plant-based diets have been classified according to the category of foods that is restricted. Scholars defined types of plant-based diets as traditional vegetarians those who generally eat their meals based on fruits and vegetables, grains, beans and nuts but exclude all flesh foods, including fish and chicken from the diet; Lacto-ovo vegetarians those who allow dairy products and eggs; Pesco-vegetarians those who allow dairy products, eggs, and fish; and Vegans those who strictly abstain animal-based foods and drinks, even they could exclude consuming any animal-derived products such as honey and leather clothing (Dobersek et al., 2020; Matta et al., 2018; Timko et al., 2012; Craig, 2010). In other literature, the types of plant-based diets have been classified as vegetarians (eschewing all meat) and flexitarians (semi-vegetarians: significantly reduce meat intake or light semi-vegetarians: mildly reduce meat intake) (De Backer & Hudders, 2014; Rosenfeld, Rothgerber & Tomiyama., 2020). Although the definition of plant-based diets varies slightly from one study to another, comparisons to a diet that completely excludes red meat appear in most studies. In this study, the term "plant-based diets" referred to all types of vegetarian diets, and the term "vegan" referred to people who do not consume all the animal-based products. "Vegetarian" and "semi-vegetarian" respectively referred to those who consume fish and dairy products but do not consume meat and poultry and those who do not consume only red meat and meat products among animal-based food.

Avoiding specific food is often a matter of choice rather than of necessity. Eating is a topic that is often referred to in our lives, and it is inseparable from everyday life in the sense of supplying energy to our body or providing interaction with others as part of social activities. The foods we select or avoid reflect our thought, including our conception of our actual or desired way of life and our perceptions of whom we wish to be identified (Fox & Wald, 2008b; Bisogni, Connors, Devine, & Sobal, 2002). Personal values and beliefs influence one's dietary choice. Therefore, personal health and morality were mainly emerged motivations to control or eschew meat consumption (De backer et al., 2015).

Health benefits were one of the most important motivations for being vegetarian because vegetarian diets have been generally considered positive and healthy (Lea & Worsley, 2003b;

Corrin & Papadopoulos, 2017; Fox & Wald, 2008a, b). The most frequently mentioned motivation, along with health motivation, was ethical motivation (Beardsworth & Keil, 1992; Fox & Wald, 2008a; Rosenfeld, 2019; Plante et al., 2019; De Baker & Hudders. 2015). Ethically motivated plant-based dieters begin to follow a plant-based diet by animal welfare, environmental concern, and religious beliefs (Rosenfeld & Burrow, 2017). Since animal-motivated vegetarians had stronger feelings of disgust toward meat and they were stricter on their dietary choice, Rosenfeld (2019) distinguished them from environmentally motivated vegetarians, but both animal and environment concerned vegetarians had a similar moral oriented goal and prosocial attitude which make different features from health-motivated plant-based dieters. Most people care about animals while they eat them. In other words, it is called the "meat paradox", which is a conflicting feeling toward animals that people desire to eat meat, at the same time, reluctant to hurt animals (Loughnan, Bastian, & Haslam, 2014). Meat eaters tend to consider animal rights and welfare less and separate them from animals to make them feel relaxed to consume meat (Loughnan, Bastian, & Haslam, 2014). While those who follow plant-based diets for ethical reasons sympathize with the feelings of pain that animals feel and think slaughtering animals for human satisfaction is unjustifiable (Beadsworth & Keil, 1992; Fox & Wald, 2008a). This ethical consideration could extend into the context of sustainability, including human inequality such as global food supply, along with ecological concerns about deforestation as well as animal welfare (Beadsworth & Keil, 1992). Ethically motivated plant-based dieters formed their motivations within a philosophical, ideological or spiritual framework. Thus meat-free diet is not just a diet. It is a lifestyle for them (Fox & Wald, 2008a).

However, diet types were not formed by one motive but by the interaction of complex motivational factors due to the ambivalence of food (Beardsworth & Keil, 1992; Plante et al., 2019). Therefore, scholars have proposed a social identity motive to being a plant-based dieter because people want to belong to a social group (Rosenfeld, Rothgerber & Tomiyama., 2020). It suggested that people want to identify themselves with social groups because of their potential benefits in a positively recognized group (Plante et al., 2019). With this regard, Rosenfeld and colleagues (2020) found in their study, when people started to limit their meat consumption, they tend to label themselves as a vegetarian to display information about their social identity even though they did not follow as strictly as other vegetarians (Rosenfeld, Rothgerber & Tomiyama., 2020). This attitude was also seen in the study by Vinnari, Montonen, Härkänen, & Männistö (2009). They conducted a survey

that asked both self-identified vegetarianism and implemented definitions based on the frequencies of animal-based food consumption. The number of self-identified vegetarians was twice as high as those calculated by the food frequency questionnaire (FFQ). Although there was a limitation in the fact that both FFQ and vegetarian identity questions were subjective, a tendency was predicted that people claimed themselves as a vegetarian when they reduced or restricted their meat intake (Vinnari et al., 2009). Therefore, plant-based dieters motivated by social identity could be more lenient on dietary rules than other vegetarians, yet they also want to belong as a plant-based diets group because they consider it is beneficial to the image of themselves (Plante et al., 2019).

University time is a transition period that students face a lot of changes (Arnett, 2000). The motivations mentioned above seem to be applied similarly when university students form their diet habits. Deliens et al. (2014) conducted a qualitative study to examine what factors influence eating behaviour among university students in Belgium. Students' eating behaviour was influenced by personal factors (e.g., food preferences, self-discipline, and beliefs), social factors (e.g., parental control, peer pressure), and environmental factors (e.g., cost, availability and accessibility, and socio-cultural norms). Along with these factors, the university's characteristics, such as residency, university lifestyle, and study, showed moderating effects on students' eating behaviour. Furthermore, Jabs et al. (1998) mentioned that enrolling on the university is a significant life transition, and this unique environment could lead to discarding existing obstacles to adopting plant-based diets. They also suggested that students might be supported by their peer group who have similar dietary behaviours while exploring new identities and practices (Jabs et al., 1998).

2.2. Mental health

Mental health is defined as "a state of well-being in which all individuals can realise their potential, cope with the normal stresses of life, work productively and rewardingly, and contribute to her or his community" (WHO, 2013). Whereas mental disorder has been defined as "suffering, disability or morbidity due to mental, neurological and substance use disorders, which can arise due to the genetic, biological and psychological make-up of individuals as well as adverse social conditions and environmental factors." (WHO, 2013). The most common mental disorder is depression which more than 264 million people have been undergoing globally (WHO, 2020). Individuals diagnosed with severe mental disorders (SMD) were more likely to be involved in lifestyle behaviours that

constitute risk factors for non-communicable diseases (NCDs), such as tobacco use, physical inactivity, and unhealthy diet. Therefore, they were more likely to be overweight or obese and had a higher mortality rate from NCDs, such as cardiovascular disease, diabetes, respiratory disease, and cancer (WHO, 2018). Furthermore, one in four young adults who live in urban areas in Finland suffered from mental disorders, and the most common was depression and anxiety (Aalto-Setälä et al., 2001). University students have shown a higher prevalence of depression than the general population (Ibrahim et al., 2012), and there has been an increasing trend of psychological symptoms among Finnish university students from 2000 to 2012 (Oksanen et al., 2017).

Depression has been considered one of the factors that can affect an individual's ability and thus hinder academic achievement (Hysenbegasi, 2005). University students with depression showed more likely lower academic performance, more absence, and interpersonal problems (Heiligenstein, 1996; Iarovici 2014, p.141). Since the characteristics of the university period, it can be a big burden to them to adjust themselves to an unfamiliar environment, receive a good grade, and plan their future. It can induce stress and make students suffer from depression (Sarokhani et al., 2013). Furthermore, poor mental health in early adulthood could lead to the accumulation of negative consequences in future adult life and negatively affect job prospects (Lerner & Henke, 2008) and social relationships (Pelkonen et al., 2003).

WHO (2018) recommended that people with mental disorders, especially those who are suffering or at risk of overweight or obese, cardiovascular disease, and diabetes, have healthier lifestyles through healthy eating and physical activities. Iarovici (2014, pp. 148-150) mentioned that lifestyle modification should be discussed with mentally distressed students, along with the therapy and medication. Appropriately planned vegetarian diets are low cholesterol, saturated fat, and calories, which can be a healthy diet that helps with cardiovascular disease, diabetes, obesity (J Am Diet Assoc, 2003; Craig, 2009). Therefore, plant-based diets may help people in certain conditions, such as suffering from both mental disorders and non-communicable disease. However, these diets are likely to lack nutrients known to be necessary for mental health. The details of the association between diet and mental health are discussed in the following section.

2.3. Diet and Mental health

There has been a growing interest in empirical studies and clinical research on the relationship between nutrition and mental health status. Unhealthy diet and lifestyle, the incidence of non-communicable disease (such as obesity, hypertension, and diabetes), and depression are important risk factors in the development of cognitive decline and dementia (Kivipelto et al., 2018). Lang et al. (2015) described the physiological perspective of the relationship between mental disorders and nutrition. According to them, nutrition influences intestinal microbiota, which influence the hormonal and neurotransmitter that associated with brain systems, it influences brain functions, such as appetite, sleep, energy intake, and mood. These influences again modulate eating behaviour and might increase mental disorders, obesity, and diabetes (Lang et al., 2015). Plant-based diets have been recommended because they were known to have beneficial health effects such as prevention of chronic diseases, cardiovascular disease, obesity, type 2 diabetes, and high blood pressure (Craig, 2009; Craig & Mangels, 2009; Le & Sabaté, 2014; Leitzmann, 2014). Furthermore, the American Diet Association supported vegetarianism, saying that properly planned vegetarian or vegan diets are nutritionally appropriate and these diets are suitable for all phases of the life cycle, from childhood to adulthood, including pregnancy and lactation (Craig & Mangels, 2009).

However, there is an insufficiency of essential nutrients such as B vitamins, vitamin D, n–3 polyunsaturated fatty acids, calcium, zinc, and iron in vegetarian diets (Craig, 2010, Helen Bishop MacDonald, 2003). An Australian study comprising female university students found that meat abstainers lacked intake of n–3 polyunsaturated fatty acids, vitamin B12, selenium, and zinc (Fayet, Flood, Petocz, & Samman, 2014). The aforementioned nutrients, especially B vitamins, vitamin D, and n-3 fatty acids have been shown a positive association with cognitive functions (Scarmeas, Anastasiou, & Yannakoulia, 2018), and those nutrients were plentiful in animal-based foods (Williams, 2007). In this regard, studies focused on the link between individual nutrients or food groups intake and depression (Jacka et al., 2010; Quirk et al., 2013). For example, Perica and Delaš (2011) reviewed the association between the shortage of essential fatty acids (n-3 and n-6) and mental disorder. They found that n-3 fatty acids helped the brain's function and that their lack of intake was associated with various mental disorders (e.g., stress, anxiety, cognitive impairment, mood disorder and schizophrenia) (Perica & Delaš, 2011). Wolfe et al. (2009) followed up with

people who participated in a national survey to find the association between dietary fatty acids composition and the risk of depressive symptoms. There was no association between saturated fatty acids and depression symptoms, but they found different results in n-6 and n-9 fatty acids intake by gender. Among men consumed higher n-6 fatty acids showed an increasing trend of the depressive symptom risk, while among women consumed higher n-9 fatty acids showed less risk of depressive symptom. He, Perfield, Green, & Armentano (2012) also studied the link between the composition of dietary fatty acids intake and depression, in their study, poly- and mono-unsaturated fatty acids were protective on the risk of depression. In contrast, trans unsaturated fatty acids were harmful to the risk of depression. Therefore, fish consumption has been highlighted as a potential risk factor to associate plant-based diets with depression (Appleton et al., 2007).

Other nutrients most studied concerning mental health and nutrition, except fatty acids, include B vitamins, vitamin D, iron, and zinc. According to Bodnar and Wisner (2005), B vitamins, iron, zinc, and selenium were associated with brain function and mood control mechanisms, and lack of nutrients mentioned above were more likely found among depressed people. Lang et al. (2015) also mentioned an inverse association between specific nutrients such as vitamin B12, vitamin D, and zinc and mental disorders. Mozaffari-Khosravi et al. (2013) conducted a randomized clinical trial among depressed patients by giving two different doses of vitamin D (3750 mcg and 7500 mcg, respectively) to improve depression symptom. The results showed there was an improvement in depression and the more dose was, the more effective. Vulser et al. (2016) found an association between depression and disease conditions derived from nutrition deficiencies. The prevalence of anaemia, which can be caused by deficiencies in certain nutrients such as vitamin B12, folic acid, iron, and zinc, was more pronounced among people with depression (Vulser et al., 2016). However, Beezhold et al. (2010) showed people who follow a vegetarian diet had better mental health status than those who do not follow a vegetarian diet even though the vegetarian diet had a low intake of omega-3 fatty acids. Moreover, Ruusunen (2013) indicated that the intake of vitamin B12 and serum concentration of n-3 PUFAs were not significantly related to the risk of depressive symptoms. However, folate intake and healthy dietary patterns showed a relationship with a lower risk of depression, whereas an unhealthy dietary pattern associated with a higher prevalence of depression (Ruusunen, 2013).

In this context, researchers have been interested in the link between foods rich in the nutrients mentioned above and the risk of depression, as well as the association between diet types and mental disorders. Dobersek et al. (2020) systematically reviewed literature that studied the relationship between plant-based diets and mental health. Although there were controversial outcomes (among 18 studies; 11 showed more vulnerable mental health outcomes in plant-based dieters, 4 showed complexed results, and 3 showed more mentally vulnerable among meat-eaters), they concluded that there was sufficient evidence to assume that those who restrict meat consumption are more likely to feel depressed, anxious, and engage in self-harm behaviours. The uncertainty remained since essential confounding factors (e.g., health-related behaviour, lifestyles, and diagnosed-disorders) were not considered enough (Dobersek et al., 2020).

It can be considered that there would be a gender difference in the relationship between diet types and mental health status since women were more likely to become plant-based dieters (Beardsworth & Keil, 1992; Nezlek, Forestell, & Newman, 2018) and were more likely to suffer from mental disorders (Oksanen et al., 2017; Ruusunen, 2013). However, there seem to be no gender-consistent patterns. Although a cross-sectional study among Turkish students (age between 17 and 21 years) showed significantly higher anxiety scores only among the female vegetarian students (Baş, Karabudak, & Kiziltan, 2005), a study by Nezlek, Forestell, & Newman (2018) indicated that vegetarian students, regardless of gender, were more likely to have a lower well-being status in terms of mood, self-esteem, and psychological adjustment. Besides, studies conducted only by one gender group showed that vegetarian dieter had more vulnerable mental health status than non-vegetarian. For example, Lindeman (2002) examined the psychological well-being of Finnish female plant-based dieters. The results showed both vegetarian and semi-vegetarian had lower self-esteem and more depressive symptoms than those who had followed the omnivorous diet. In addition, vegetarian women perceived the world more negatively than both semi-vegetarian and omnivores did. Hibbeln et al. (2018) conducted a study on male partners of pregnant women. They adjusted potential confounding factors (e.g., socio-demographic factors, family history of depression, previous childhood psychiatric contact, smoke and alcohol consumption), then they found that vegetarian men showed more depressive symptoms than non-vegetarian men. A meta-analysis study conducted by Iguacel et al. (2020) found that vegan and vegetarian were more likely to experience depression symptoms, but no gender-consistent patterns

were found in subgroup analyses. However, an age difference indicated more vulnerable mental health outcomes among those under 26 years of age. (Iguacel et al., 2020).

Although studies have shown the association between meat-free diets and mental disorders among a broad range of age groups (Beezhold et al., 2015; Lindeman 2002; Matta et al., 2018; Michalak et al., 2012), many studies have been conducted among younger generations. It may reflect the trends that younger people were more likely to consume plant-based foods (Jallinoja et al., 2016) and an increasing tendency of the prevalence of mental disorders among university students globally (Oksanen et al., 2017; Sarokhani et al., 2013; Schofield et al., 2016). For example, a study among young Australian women (22-27 years old) showed both vegetarian (i.e., no meat, poultry, and fish) and semi-vegetarian (i.e., no red meat) had vulnerable mental health than non-vegetarian (Baines et al., 2007). Forestell & Nezlek (2018) showed similar results that vegetarian and semi-vegetarian university students in the USA were more depressed than omnivores. Baş, Karabudak, & Kiziltan (2005) researched Turkish students aged 17-21, female vegetarians showed higher anxiety scores than those who did not follow vegetarian diets. Lavallee et al. (2019) also found that depression and anxiety rates increased over time among vegetarian students in China, but no such association was found in German students. They also looked at samples of adult populations from Germany, Russia, and the United States, but there was no significant association (Lavallee et al., 2019). In similar line with this, Timko et al. (2012) did not find a significant difference between diet types (i.e., vegan, vegetarian, semi-vegetarian, and non-vegetarian) and general mental health among American university students.

Besides, the study by Timko et al. (2012) showed that vegetarians and vegans had the healthiest weight and eating behaviour. Parallel with this, a cross-sectional study illustrated that plant-based diets appear favourable association with mental status (Beezhold, Radnitz, Rinne, & DiMatteo, 2015). The vegan participants showed that they had less stress (particularly among female participants) and anxiety (particularly among male participants) than those who consume animal-based food (Beezhold et al., 2015). The researchers assumed that this could be because vegan participants had more fruits and vegetables than vegetarian and omnivorous participants. Fruits and vegetables can provide rich antioxidant nutrients and phytochemicals, and their intake has been linked to lower biomarkers of oxidative stress and inflammation as well as better mental health (Beezhold et al., 2015). Furthermore, a randomized control trial conducted by Beezhold and

Johnston (2012) showed that following plant-based diets could improve mood status. Matta et al. (2018) focused on finding the association after adjusting for several confounding factors such as sociodemographics, health behaviours, and chronic diseases conditions. They were found that pesco-vegetarian and lacto-ovo-vegetarian showed more probability to suffer depression than omnivores. The statistical significance was remained after adjusting for all the potential confounding factors, whereas vegan showed a significant association with depression only before adjusting for potential confounding factors. They also suggested the relationship between the number of restricted food items and depressive symptoms, regardless of dietary types (Matta et al., 2018).

There is no clear evidence to support the causal relationship between diets which exclude animal-based food and mental disorders. However, there is an association that certain nutrients, eating patterns or lifestyle factors can potentially affect mental health status. Therefore, it is important to clarify the relationship between excluding or consuming meat and mental health because diet types can be crucial in determining mental health conditions. Besides, the possible confounding factors should be considered while analysing the association.

2.4. Diet and Academic achievement

Starting university means facing a variety of different changes than before. Students live alone or with friends, independent of their parents. They also may leave where they grew up and move to another city or country. The academic environment is different from their secondary education. For example, students should create their academic schedules and manage their time rather than follow a set timetable. Students are guaranteed freedom of choice, but with greater responsibility for their decisions. It is one of the crucial transition times for one's life cycle, and the behaviour which builds in this time may go lifelong (Cluskey & Grobe, 2009). According to Deliens et al. (2014), these environmental changes could influence student's eating behaviour. They conducted a focus group interview with Belgian university students. The students noted that changes in the new environment they encountered since they went to the university were affecting their eating habits. For example, their food preferences, a taste of food, stress levels, and their knowledge of the diet derive them from making their food choices along with the autonomy of choice. Although previous eating habits (especially those formed by parents' influence) still affect them after they

became undergraduate students, influences from friends and peer groups, changes in their values and beliefs, and social interaction lead them to form new eating habits (Deliens et al., 2014). With these changes in the academic environment and life course may influence students' academic achievement. There are various factors and not only diet affecting academic achievements, such as drinking habit, quality of sleep, and mental health state (Singleton & Wolfson, 2009; Trockel et al., 2000; Reuter et al., 2020. Hysenbegasi et al., 2005). Among these factors, interest in the relationship between eating habits and academic achievement is increasing.

Research on diet-related academic achievement has drawn more attention among children (Blai, 1975; Burrow et al., 2017). It has been reported that there is a significant association between breakfast consumption and academic achievement among children and adolescents (Adolphus, Lawton, & Dye, 2013; Burrows, Goldman, Pursey, & Lim, 2017; Nyaradi et al., 2014). According to a systematic study by Burrows, Goldman, Pursey, and Lim, (2017), students aged 5–18 years showed the links between diet and academic achievement. They found positive links between regular meal and breakfast intake, lower consumption of energy-dense food or poor nutrition-valued foods, and better quality of eating patterns and higher academic achievement.

Scholars have extended their attention to university student to find the link between dietary habits and academic achievement due to the unique characteristics of university life and the importance of academic achievement for future work career. Results observed in university students were similar to those found in children's studies. Blai (1975) conducted a cross-sectional study among undergraduate female students in the USA to see the association between eating pattern and grade point average (GPA) score. The results showed students who regularly consumed 2-3 times a meal per day had higher GPA scores than those who have less than two mealtimes per day. Researchers have also noted, in studies of the university population, the frequency of breakfast among eating patterns associated with high academic achievement (Trockel et al., 2000; Phillips et al., 2005; Reuter et al., 2020). Peltzer et al. (2015) found that university students with adequate fruit and vegetable intake were more likely to perceive they had better academic achievement than those with inadequate fruit and vegetable intake. Also, higher diet quality was observed to associate with better academic achievement among undergraduate students (Whatnall et al., 2019). In contrast, fast food or processed food consumption indicated a negative relationship with academic achievement (Reuter et al., 2020; Deliens et al., 2013).

In this context, there might be an association between plant-based diets and better academic achievement among undergraduate students because a plant-based diet could provide more fruits and vegetables and higher diet quality. At the same time, plant-based diets might also be associated with poorer academic achievement since plant-based diets might derive adverse mental health.

3. RESEARCH QUESTIONS

According to the World Health Organization (2018), a healthy diet is one of the recommended actions to treat mental disorders. Plant-based diets provide lower consumption of saturated fat and cholesterol and higher consumption of fruits, vegetables, nuts, and whole grains, which increase fibre and phytochemicals intake (Lea & Worsley, 2003a; Craig & Mangels, 2009). In this sense, plant-based diets have been considered a healthy diet. Besides, well-planned plant-based diets are nutritionally appropriate and suitable for all life cycle stages (Craig & Mangels, 2009). Furthermore, those interested in consuming plant-based products were young (25-34), living in urban areas, and highly educated individuals (Jallinoja et al., 2016). The undergraduate period is a time of finding a new balance of study, work, and life and facing various life changes as they begin a new life stage. Mental health is a major factor contributing to overall well-being since poor mental health in early adulthood can lead to the accumulation of negative consequences in future adult life and negatively affect job prospects (Lerner & Henke, 2008) and social relationships (Pelkonen et al., 2003).

Previous studies have tried to find a link between plant-based diets and mental health, but conflicting results have been observed. Besides, most studies that looked at undergraduate students' academic achievement were concerned with dietary behaviour (e.g., breakfast intake, consumption of energy-dense food or poor nutrition-valued foods, and quality of eating patterns). In this study, I tried to deal with different degrees of mental health status and academic achievement among Finnish higher education students according to their diet types (i.e., vegan, vegetarian, semi-vegetarian, and omnivore). Among many other variables, this thesis focused on three outcome variables: diagnosed mental disorders, GHQ-12 scores, and perceived academic achievement. Socio-demographic factors, health-related factors, and disease conditions also considered when performing the analyses. Specifically, this study aimed to investigate the following two research questions:

1. Are plant-based diet types associated with mental health status as assessed by both clinically diagnosed mental disorders and minor psychiatric disorders among higher education students in Finland?
2. Are plant-based diet types associated with academic achievement among higher education students in Finland?

4. METHODS

The University Student Health Survey has been conducted every four years since 2000 by the Finnish Student Health Service (FSHS). These series of the survey have been carried out nationwide although the first two surveys only included students from academic universities, yet students from universities of applied sciences included from 2008. The survey aimed to provide information about students' health and health-related behaviour in Finnish higher education institutions. Therefore, this cross-sectional survey comprised questions that could examine topics such as physical and mental health state, health-related behaviour, study ability, and eating habits. In this study, the 2016 Student Health Survey was used. The data has been collected online in digital format, except for one reminder sent by mail in paper form. The Ethics Committee of the University of Turku approved the study protocol. All the students in the sample gave their informed consent voluntarily by responding to the questionnaire. The data was acquired based on research ethical procedures from the Finnish Social Science Data Archive (FSD) for the purpose of this thesis. Furthermore, the data were treated as confidential and used to obtain results in accordance with the ethics guidelines of the Finnish National Advisory Board on Research Integrity.

In addition, variables and analytical models have been adopted from the study of Matta et al. (2018) and applied based on the characteristics of the questionnaire used in this study.

4.1. Participants

The survey participants were Finnish undergraduate students aged 18- to 35-year-old who registered as a present student for the 2015-2016 academic year in either Finnish academic universities or universities of applied sciences. The National Defence University, Åland University of Applied Sciences, and the Police University College were not included in this survey because they were not part of the target population. The participants from the academic universities students were selected from a customer registration system of the Finnish Student Health Service, and the participants from the universities of applied sciences were obtained from the institutions' student register.

The sample size was 10,000 from students from FSHS's register and students from the registers of universities of applied sciences (4,996 and 5,004 respectively). Universities of applied sciences

were asked to pick every 19th student who met the criteria into the sample. Whereas the stratified random sample of academic universities students was drawn from FSHS's customer register by the municipality in each location where the FSHS provided services for students. Thus, the stratification of the academic universities' student sample differs slightly from the sample of students from universities of applied sciences because students in university units located in another municipality were included as customers of FSHS in the university's main location. Therefore, the students were stratified according to the municipality and thus indirectly according to the university. The sample of this study equals 4.8% of the target population. Males accounted for 47.7%, and females 52.3%. Students under the age of 25 constituted 58% of the sample. The response rates were 39% and 25%, respectively, in academic universities and universities of applied science, and the overall response rate was 31% (n = 3110).

The response rate of this survey has been decreased over the years, but it is a similar respondent rate as other surveys targeted for the same age group of students (Kunttu et al., 2017). Furthermore, an analysis of non-response bias showed no accumulative health problems among non-respondents and no significant differences were observed in the survey results compared to the previous surveys (Kunttu et al., 2017). Although academic university students responded slightly more actively to the questionnaire than students from the university of applied science (59.7% and 40.3% respectively) and male respondents were underrepresented (34.5%), the representativeness of the sample was appropriate (Kunttu et al., 2017). In the present study, no weighting adjustment was used. The participants' description can be seen in table 1.

Table 1. Participants' description of the University Student Health Survey 2016

	n	%
Gender (n missing = 20)		
Men	1068	34.6
Women	2022	65.4
Age (n missing = 208)		
18-21	428	14.7
22-24	1073	37
25-27	774	26.7
28-30	368	12.7
31-33	203	7
Over 33	56	1.9
Institutions		
Academic university	1856	59.7
University of applied sciences	1254	40.3
Location (n missing = 125)		
Helsinki-Uusimaa	974	32.4
Southern Finland	501	16.1
Western Finland	842	27.1
Northern and Eastern Finland	668	21.5

4.2. Variables

4.2.1. Diet types

Eating habits were investigated based on the Index of Diet Quality (IDQ). The questionnaire included the consumption of wholegrain products, fish, red meat (beef, pork, mutton, game) or meat products (sausage, cold-cut meat/lunch meat), poultry (chicken or turkey), dairy products, vegetables, fruits and berries, juice made of fruits and berries, soft drinks, and sweets. The question measured the frequency of each food items: *"On how many days a week do you: Eat the food item"* on a scale ranging from 0 (Less often than once a week) to 7 (Every day); quantity was not included. The frequency of each food items by diet types is shown in figure 2.

Among the food items from IDQ, six food items (red meat or meat products, poultry, fish, dairy products, vegetables, and fruits and berries) were selected to classify the following groups of diet types: (1) vegan who does not consume all the animal-based products; (2) vegetarian who consumes fish and dairy products, but no meat and poultry (3) semi-vegetarian who does not consume only red meat or meat products but could consume fish, poultry, and dairy products (4)

omnivorous who consume any types of food items, in other words, no restrictions on food items (control).

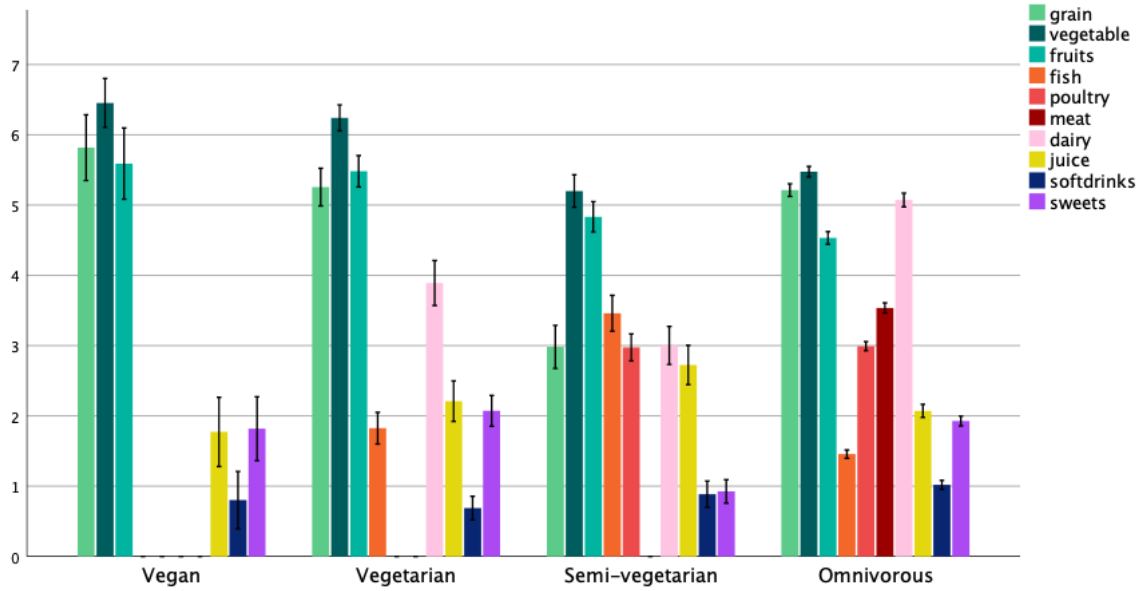

Figure 2. Mean and 95% confidence interval (CI) for frequency of food intake by diet type

4.2.2. Mental Health

Diagnosed mental disorders

The diagnosed mental disorders were studied by using questions with *"Has a doctor/dentist/psychologist diagnosed you with a long-lasting or recurring illness/disorder/health problem which has given you symptoms or has been treated during the past 12 months: Anxiety disorder (e.g., panic attacks)?"* and *"Has a doctor/dentist/psychologist diagnosed you with a long-lasting or recurring illness/disorder/health problem which has given you symptoms or has been treated during the past 12 months: Depression?"* The respondents answered either 0 (No) or 1 (Yes) for both questions. In the analyses, these two questions were combined into one variable called mental disorders since depression and anxiety were strongly associated (Schofield et al., 2016; Barnett et al., 2012). The correlation coefficient for these items was .537 indicating acceptable reliability. The respondents who answered they had not been diagnosed with both anxiety and depression were merged into a "0 = having no mental disorder" category, and

respondents who responded that either or both had been diagnosed into a "1 = having mental disorders" category. The prevalence of mental disorder was 12.1% among total samples.

Minor psychiatric disorders status

For checking the current condition, items of the General Health Questionnaire (GHQ) were asked to participants. GHQ has been widely used as self-reporting measurements for evaluating current minor psychiatric disorders. Among several other versions (e.g., 60 items, 30 items, 28 items, and 20 items), GHQ-12 has been used the most since it has relatively good validity and efficiency (Anjara, Bonetto, Van Bortel, & Brayne, 2020; Mäkikangas et al., 2006). GHQ-12 has been used to screen minor changes in the mental state compared to the usual mental state, not long-standing mental disorders (Mäkikangas et al., 2006). This scale identifies minor psychiatric disorders by following questions, for example, *"Have you recently been feeling unhappy and depressed?" "Have you recently lost much sleep over worry?" "Have you recently felt you couldn't overcome your difficulties?" "Have you recently felt constantly under strain?"* The range of responses was scored from 1 (Not at all) to 4 (Much more than usual) for negative items and from 1 (Rather more than usual) to 4 (Much less than usual) for positive items. The scale can be seen in Appendix 1.

In this study, the cases were classified as a cut-off point of four or over. The scores were calculated using the scoring method used in Oksanen et al. (2017)'s study of the 12 years trend of mental distress among Finnish university students. In this method, individual scores for each response were adjusted to 0-0-1-1, meaning that the responses with 1 and 2 were scored as 0, and 3 and 4 were scored as 1. Thus, the range of 0-12 was given, and the higher the score, the worse the mental health. Reliability was assessed as Cronbach's alpha and was 0.89 for the present sample. The average GHQ-12 score was 2.79 (SD = 3.3). Almost 30 % of students were classified as 1 (case) by the total score of four or higher, and the rest of the students who scored under 4 were classified 0 (non-case) (See figure 3).

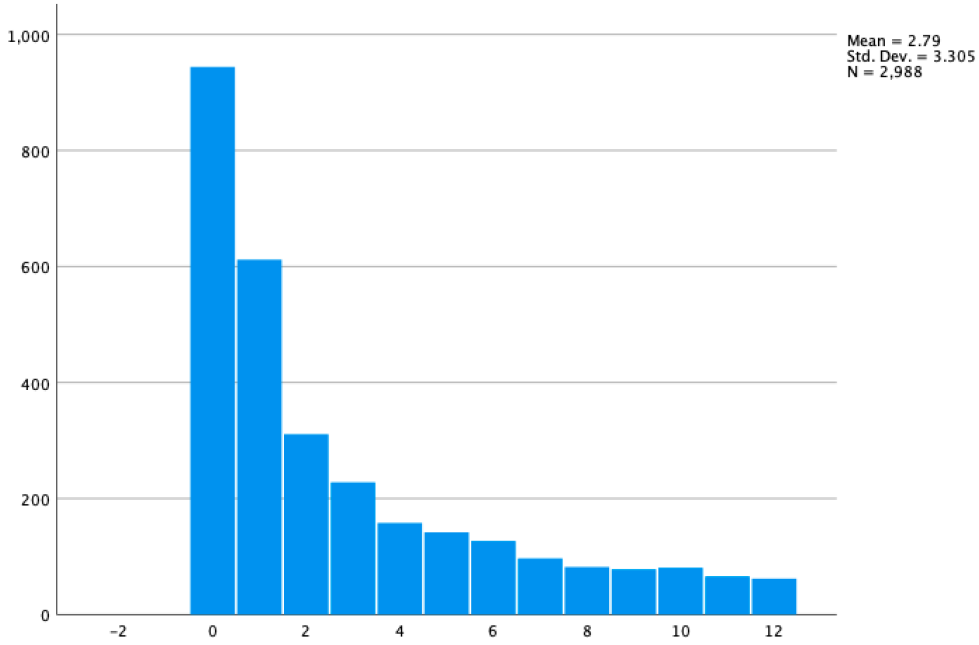

Figure 3. Frequency distribution of General Health Questionnaire-12 (GHQ-12)

4.2.3. Academic Achievement

Academic achievement was measured with the question, *"If you think about your own goals, how successful do you think you have been in your studies?"* This question was a subjective perception of academic achievement, and the participants answered on three scales based on their perceived academic achievement: "more successful than expected", "as successful as expected", and "less success than expected." The answers were dichotomised into 0 (successful) with the answer of "more successful than expected" and "as successful as expected" and 1 (less successful) with the answer of "less success than expected."

4.2.4. Health-related behaviour and Body Mass Index (BMI)

Physical activity was measured with the question *"How often do you engage in free-time physical activity for a minimum of half an hour so that you sweat and become at least slightly short of breath (e.g., jogging, cycling, gymnastics, swimming, ball games)?"* The respondents were able to answer: 0 (never or very seldom), 1 (1-3 times a month), 2 (about once a week), 3 (2-3 times a week), 4 (4-6 times a week), and 5 (daily). (Overall $M = 2.45$, $SD = \pm 1.34$)

Smoking habit was asked with the question, *"Do you use or have you previously used tobacco products: Do you Smoke?"* The answers were consisted of "Not at all", "Previously, but I have quit", "Yes, less often than once a week", "Yes, weekly but not daily", and "Yes, daily". The answers were set to 0 (never and former smoker) (control) and 1 (current smokers regardless of frequency) for the analyses.

Alcohol consumption was measured with the question, *"How often do you consume beer, wine or other alcoholic drinks? Please also include the times when you have consumed only small amounts, for instance, a bottle of lager (0.33 litres) or a drop of wine."* The options for answers were "Never", "About once a month or less often", "About 2-4 times a month", "2-3 times a week", and "4 or more times a week". In the analyses, the answer was dichotomised into 0 (those who answered they never drank) (control) and 1 (those who answered they drank regardless of frequency).

Body Mass Index (BMI) was calculated based on the weight and height the respondents reported themselves. (Overall M = 23.74, SD= ±3.67)

4.2.5. Disease conditions

The general state of health and the state of chronic disease were asked with the questions "*Has a doctor/dentist/psychologist diagnosed you with a long-lasting or recurring illness/disorder/health problem which has given you symptoms or has been treated during the past 12 months (e.g., diabetes, blood pressure, lactose intolerance, asthma).*" The answer has consisted of 0 (No) or 1 (Yes). There was a total of 34 questions in the disease conditions, of which 13 diseases, including chronic diseases, were first selected as variables, except for questions such as mental health, eating disorders, and dental diseases. Finally, six diseases were selected except for diseases with insufficient rates of disease and many missing values: Allergic rhinitis, Atopic dermatitis, Acne, Lactose intolerance, Gastrointestinal condition, and Renal disease. For the logistic regression, disease conditions were treated as the sum of total diagnosed diseases, and it ranged from 0 (no disease) to 6 (all disease).

4.2.6. Other Variables

As background questions, the respondents were asked about socio-demographic characteristics, such as age, gender, location and institution. The answers of age were grouped into "19-21 years", "22-24 years", "25-27 years", "28-30 years", "31-33 years", and "Over 33 years." The answers of gender were categorised into "Male", "Female", and " Not known or unspecified." The answers of the universities' location were classified into "Helsinki-Uusimaa", "Southern Finland", "Western Finland", "Northern and Eastern Finland", " Åland Islands", and "Not known or unspecified." Lastly, the answers of higher education institution were classified into "University of applied sciences" and "University."

The number of years the respondents had been enrolled as 'present' for current studies was asked with the question, *"For how many academic years have you been enrolled and registered for attendance in connection with your present studies?"* The answers were categorised into "Under 3 years", "3-6 years", and "Over 6 years."

The confidence of having chosen the right field of study was measured by asking, *"Do you feel that your field of study is the right one for you?"* This question could be answered simply by "Yes", "No", and "Can't say". In the analyses, "Can't say" was classified into the same group with "No" to make the variable dichotomous.

4.3. Analyses

The first step was to provide the sample's characteristics by diet types that were vegan, vegetarian, semi-vegetarian, and omnivorous. Descriptive statistics were presented percentages or means and standard deviations (SD) by the types of variables. The chi-square test obtained the p-value of the variables presented in percentile, and the one-way ANOVA obtained the p-value of the variables presented in mean and standard deviation (SD).

Logistic regression was performed to examine the association between diet types and mental health and the association between diet types and academic achievement. Diet types were considered as a four-class categorical variable (omnivorous, semi-vegetarian, vegetarian, and vegan). Clinically diagnosed mental disorders (No vs Yes), GHQ-12 screened minor psychiatric disorders (GHQ-12 score <4 vs ≥ 4), and academic achievement (successful vs less successful) were dependent

variables and were performed in logistic regression, respectively. The logistic regression models were adjusted for potential confounding factors (i.e., age, gender, locations, institution types, health behaviours, BMI, disease conditions). Age, food items, physical activities, BMI, and disease conditions were included as a continuous variable, while the other variables were included as categorical variables. The results were estimated with odds ratios (OR) and their 95% confidence intervals (CI).

In the case of mental health were conducted separately by degrees of mental disorders. Both clinically diagnosed mental disorders and GHQ-12 screened minor psychiatric disorders were estimated with five logistic regression models:

- Model 1 predicted the mental disorders by diet types
- Model 2 added demographic variables (age, gender, locations, and types of institution)
- Model 3 was further adjusted for the consumption of whole grain, vegetables, and fruits
- Model 4 was adjusted for health behaviours (smoking, alcohol consumption, and physical activity) and BMI
- Model 5 was further adjusted for disease conditions to check whether the disease conditions influenced the choice of diet types.

Although there was no statistical significance on diet types and academic achievement in the chi-square result, I conducted the logistic regression to check possible association after adjusted several potential confounding factors. Academic achievement was predicted with six models. The models were adjusted in the same orders as mental disorders models until Model 5, yet Model 6 was further adjusted for enrollment status and self-evaluation of the choice of the right studies.

Further exploratory analyses were conducted to examine the association between food groups and academic achievement by logistic regression. In model 1, academic achievement was the dependent variable, and food items (wholegrain products, fish, red meat or meat products, poultry, dairy products, vegetables, fruits and berries, juice, soft drinks, and sweets) was included as a continuous variable. Model 2 were further adjusted for age, gender, locations, institution types, health behaviours, BMI, disease conditions, enrollment, and right field of study from Model 1.

All analyses were carried out using IBM SPSS Statistic for macOS, version 27.

5. RESULTS

The descriptive characteristics of the study sample according to diet types were shown in Table 2. Among the 3110 participants in the initial sample, each diet types were 67 vegans (2.2%), 281 vegetarians (9.3%), 291 semi-vegetarian (9.6%), and 2390 omnivorous (78.9%) after dropped 81 participants out because of missing values on the questions from the IDQ. Most of the participants were under 30 years old regardless of their diet types. In line with this trend, those who registered for their study under 3 years were predominant, especially among vegans (74.2%) and omnivores (75.3%). The proportion of female participants prevails in all diet types. Students who have followed vegan or vegetarian diets were more likely to study at the universities located in Helsinki-Uusimaa and Western Finland regions. Excluding the semi-vegetarian group (45.6%), more than half of the students in each diet group thought they were studying in the right field of studies. There was no statistical significance in the chi-square test regarding the study achievement. However, vegan and vegetarian had more ratios of diagnosed mental disorders (22.0% and 23.0%, respectively, $p<0.001$) and were more screened by GHQ-12 scores (33.9% and 36.9%, respectively, $p<0.012$) than semi-vegetarian and omnivore students. The mean of physical activity was above 2.00 for all diet types, and it was estimated that most of the students exercised more than once a week. However, in the vegan group, the mean of physical activity was 2.03±1.36, the lowest mean value among the different diet groups. Among other health-related behaviour factors, in smoking and drinking habits, the semi-vegetarian group showed that the least percentage of students do so. This group also showed the lowest incidence of disease in disease conditions except for lactose intolerance. Lastly, the mean BMI of all diet groups were below 24.9, which indicates that most of the students were in the healthy weight range. However, both vegan and vegetarian groups belonged to a slightly lower average BMI range than both semi-vegetarian and omnivorous groups.

Table 2. Participant's characteristics by diet types.

Diet types (n = 3029)	**Vegan** (n = 67)		**Vegetarian** (n = 281)		**Semi-vegetarian** (n = 291)		**Omnivorous** (n = 2390)		***P*-value**
Age (n missing = 205)									.006
19 – 24 years	29	44.6%	117	44.8%	86	42.6%	1233	53.7%	
25 - 30 years	29	44.6%	113	43.3%	97	48.0%	871	37.9%	
Over 31 years	7	10.8%	31	11.9%	19	9.4%	192	8.4%	
Gender (n missing = 19)									<.001
Male	8	12.1%	55	19.8%	63	21.7%	913	38.4%	
Female	58	87.9%	223	80.2%	227	78.3%	1463	61.6%	
Location (n missing = 120)									.044
Helsinki-Uusimaa	26	41.3%	113	41.1%	97	34.6%	717	31.3%	
Southern Finland	12	19.0%	40	14.5%	43	15.4%	393	17.2%	
Western Finland	15	23.8%	62	22.5%	85	30.4%	650	28.4%	
Northern and Eastern Finland	10	15.9%	60	21.8%	55	19.6 %	531	23.2%	
Type of institution									<.001
University of applied sciences	19	28.4%	75	26.7%	141	48.5%	980	41.0%	
Academic University	48	71.6%	206	73.3%	150	51.5%	1410	59.0%	
Registered years (n missing = 71)									<.001
Under 3 years	49	74.2%	192	69.6%	165	60.7%	1764	75.3%	
3 - 6 years	14	21.2%	66	23.9%	93	34.2%	498	21.2%	
Over 6 years	3	4.50%	18	6.5%	14	5.1%	82	3.5%	
The right field of study (n missing = 61)									<.001
Yes	40	62.5%	174	64.2%	125	45.6%	1565	66.3%	
No/Can't say	24	37.5%	97	35.8%	149	54.4%	794	33.7%	
Study successful (n missing = 62)									.562
Successful	49	74.2%	226	81.6%	226	79.9%	1892	80.8%	
Less successful	17	25.8%	51	18.4%	57	20.1%	449	19.2%	
Mental disorder (n missing = 658)									<.001
No	46	78.0%	164	77.0%	87	80.6%	1786	89.7%	
Yes	13	22.0%	49	23.0%	21	19.4%	205	10.3%	
GHQ-12 score ≥ 4 (n missing = 112)									.012
No	41	66.1%	173	63.1%	212	75.4%	1627	70.7%	
Yes	21	33.9%	101	36.9%	69	24.6%	673	29.3%	
Physical activity (n missing = 16)	2.03±1.36		2.25±1.32		2.09±1.22		2.52±1.35		<.001
Alcohol (n missing = 48)									<.001
Never	8	12.5%	55	20.0%	178	61.8%	367	15.6%	
Yes	56	87.5%	220	80.0%	110	38.2%	1987	84.4%	
Smoking (n missing = 50)									.035
Not at all or quitted	54	81.8%	221	80.4%	248	89.2%	1974	83.6%	
Yes	12	18.2%	54	19.6%	30	10.8%	386	16.4%	
BMI (n missing = 56)	22.78±3.68		22.82±3.37		23.8±4.01		23.85±3.63		<.001
Disease conditions									
Allergic rhinitis (n missing = 212)	10	15.9%	28	11.2%	19	6.8%	352	15.8%	<.001
Atopic dermatitis (n missing = 218)	7	11.3%	31	12.2%	10	3.6%	218	9.9%	.003
Acne (n missing = 246)	7	11.3%	21	8.4%	8	2.9%	161	7.3%	.018
Lactose intolerance (n missing = 227)	3	4.8%	14	5.6%	14	5.0%	194	8.8%	.042
GI conditions (n missing = 224)	6	9.7%	14	5.5%	9	3.2%	143	6.5%	.101
Renal disease (n missing = 250)	4	6.8%	6	2.4%	4	1.4%	53	2.4%	.114

* Figures indicate n (%) except for physical activity and BMI which indicate mean (standard deviation)

5.1. Association between diet types and diagnosed mental disorders

Table 3 presents the results of logistic regression analysis of diagnosed mental disorders according to diet types. In Model 1, those who follow semi-vegetarian and vegetarian diet types were significantly more likely to be diagnosed with the mental disorders than those who follow the omnivorous diet (OR [95% CI]: 1.86[1.08–3.22], $p<0.05$ and OR [95% CI]: 2.54[1.74-3.70], $p<0.001$, respectively). After adjusting for socio-demographic factors in Model 2, the odds ratios were decreased in all diet types, especially, the significant association with semi-vegetarian was no longer remained. After other food factors (i.e., whole grain, vegetable, and fruits) were included in Model 3, the odds ratio was increased, but the association remained significant only in the vegetarian diet type. Further adjusting for health-related behaviour (e.g., smoking, alcohol intake, and physical activity) and BMI in Model 4, the significant association still observed only in the vegetarian group (OR [95% CI]: 2.47 [1.65–3.71], $p<0.001$). This significant association did not change after adjustment for all potential confounders in Model 5 (OR [95% CI]: 2.75 [1.81–4.18], $p<0.001$).

Based on the results from Model 5, students who were older, female, smoking cigarettes, higher BMI score, and having more disease conditions were more likely to have diagnosed mental disorders. Whereas those who do more physical exercise seem to have a lower incidence of diagnosed mental disorders (OR [95% CI]: .87 [.78–.97], $p<0.01$).

Table 3. The association of diet types with diagnosed disorders (0 = No, 1 = Yes)

Type of diet	Model 1	Model 2	Model 3	Model 4	Model 5
Omnivorous	1	1	1	1	1
Semi-vegetarian(í)	1.86(1.08-3.22)*	1.483(.85-2.59)	1.56(.89-2.75)	1.58(.89-2.80)	1.73(.97-3.09)
Vegetarian(ñ)	2.54(1.74-3.70)***	2.23(1.514-3.28)***	2.53(1.70-3.77)***	2.47(1.65-3.71)***	2.74(1.80-4.16)***
Vegan(ÿ)	1.82(.84-3.96)	1.49(.68-3.28)	1.67(.75-3.72)	1.58(.70-3.54)	1.53(.67-3.52)
Age		1.27(1.14-1.42)***	1.29(1.15-1.44)***	1.24(1.11-1.39)***	1.25(1.11-1.40)***
Male		1	1	1	1
Female		1.82(1.33-2.48)***	2.09(1.51-2.89)***	2.00(1.44-2.78)***	1.75(1.25-2.45)**
Helsinki-Uusimaa		1	1	1	1
Southern Finland		.89(.60-1.33)	.87(.58-1.29)	.87(.58-1.29)	.89(.59-1.34)
Western Finland		.78(.55-1.11)	.75(.53-1.07)	.73(.51-1.05)	.72(.50-1.04)
Northern and Eastern Finland		.89(.61-1.29)	.87(.59-1.26)	.87(.59-1.27)	.89(.60-1.31)
University		1	1	1	1
University of applied sciences		.99(.75-1.32)	.94(.71-1.26)	.84(.62-1.13)	.87(.64-1.17)
Wholegrains			.95(.85-1.03)	.96(.90-1.04)	.97(.90-1.05)
Vegetables			.93(.85-1.03)	.94(.86-1.04)	.94(.85-1.04)
Fruits			.94(.87-1.01)	.98(.91-1.06)	96(.89-1.04)
Physical				.86(.77-.95)**	.87(.78-.97)**
Non-smoker				1	1
Smoker				1.39(.98-1.98)	1.47(1.03-2.09)*
Non-drinker				1	1
Drinker				1.16(.68-1.96)	1.18(.69-2.02)
BMI				1.05(1.02-1.09)**	1.06(1.02-1.10)**
Disease					1.69(1.46-1.96)***

(í) not eating only meat; (ñ) not eating meat and poultry; (ÿ) not eating meat, poultry, fish, and dairies
Model 1: diet type; Model 2: Model 1 + age, sex, location, and institution; Model 3: Model 2 + whole grains, vegetables, and fruits consumption; Model 4: Model 3 + smoking, alcohol, BMI and physical activity; Model 5: Model 4 + disease conditions. n = 2093 (i.e., participants with no missing data for the variables included in the models).
*p<0.05, **p<0.01, ***p<0.001 Odds-Ratios (95% confidence interval)

5.2. Association between diet types and minor psychiatric disorders (GHQ-12)

Table 4 shows the results of logistic regression for the association between minor psychiatric disorders screened by GHQ-12 scores and diet types. The results showed that the significant association observed only in the vegetarian diet type in Model 1 (OR [95% CI]: 1.57 [1.16–2.12], $p<0.01$). The statistical significance of the vegetarian diet remained through the whole models (OR [95% CI]: 1.68 [1.22–2.30], $p<0.01$, in Model 5). Furthermore, the odds ratio slightly increased each time except for Model 2.

After adjustment for socio-demographic factors in Model 2, the gender difference was observed. Female students were more likely to be diagnosed with minor psychiatric disorders than male students (OR [95% CI]: 1.36 [1.12–1.66], $p<0.001$). A similar trend of results was observed throughout Model 3, 4, and 5. Although the association between consuming more fruit and minor psychiatric disorders was observed in Model 3 (OR [95% CI]: .93 [.89–.98], $p<0.01$), no significant associations were observed after adjustment for the health-related behaviours, BMI, and disease conditions.

The association between the prevalence of minor psychiatric disorders screened by GHQ-12 and students who were female, smoker, drinker, higher BMI score remained after the adjustment of the potential variables for each model. It is similar associations in terms of characteristic factors observed in the results of diagnosed mental disorder.

Table 4. The association of diet type with minor psychiatric disorders (GHQ-12) (0 = No, 1 = Yes)

Type of diet	Model 1	Model 2	Model 3	Model 4	Model 5
Omnivorous	1	1	1	1	1
Semi-vegetarian(í)	.76(.52-1.1)	.70(.48-1.02)	.71(.48-1.04)	.79(.53-1.17)	.79(.53-1.13)
Vegetarian(ñ)	1.57(1.16-2.12)**	1.51(1.11-2.05)**	1.65(1.21-2.25)**	1.67(1.22-2.30)**	1.68(1.22-2.30)**
Vegan(ÿ)	1.03(.54-1.99)	.95(.49-1.83)	1.01(.52-1.97)	1.02(.52-1.99)	1.01(.52-1.99)
Age		1.06(.98-1.15)	1.07(.99-1.16)	1.04(.96-1.13)	1.04(.96-1.13)
Male		1	1	1	1
Female		1.36(1.12-1.66)**	1.54(1.25-1.89)***	1.54(1.25-1.91)***	1.53(1.24-1.90)***
Helsinki-Uusimaa		1	1	1	1
Southern Finland		.93(.71-1.22)	.92(.70-1.21)	.90(.68-1.19)	.90(.68-1.19)
Western Finland		.94(.74-1.19)	.94(.74-1.19)	.917(.72-1.166)	.92(.72-1.17)
Northern and Eastern Finland		.99(.77-1.28)	1.00(.77-1.29)	1.005(.776-1.301)	1.00(.78-1.30)
University		1	1	1	1
University of applied sciences		1.15(.95-1.39)	1.13(.93-1.37)	1.024(.84-1.248)	1.03(.84-1.25)
Wholegrains			1.00(.96-1.05)	1.01(.96-1.06)	1.01(.96-1.06)
Vegetables			.96(.90-1.02)	.95(.90-1.02)	.95(.90-1.02)
Fruits			.93(.89-.98)**	.96(.91-1.01)	.96(.91-1.01)
Physical				.94(.88-1.02)	.94(.88-1.02)
Non-smoker				1	1
Smoker				1.41(1.10-1.80)**	1.41(1.10-1.81)**
Non-drinker				1	1
Drinker				1.35(1.01-1.81)*	1.34(1.00-1.80)*
BMI				1.05(1.03-1.08)***	1.05(1.03-1.08)***
Disease					1.04(.92-1.17)

(í) not eating only meat; (ñ) not eating meat and poultry; (ÿ) not eating meat, poultry, fish, and dairies; Model 1: diet type; Model 2: Model 1 + age, sex, location, and institution; Model 3: Model 2 + whole grains, vegetables, and fruits consumption; Model 4: Model 3 + smoking, alcohol, BMI and physical activity; Model 5: Model 4 + disease conditions. n = 2218 (i.e., participants with no missing data for the variables included in the models). *p<0.05, **p<0.01, ***p<0.001 Odds-Ratios (95% confidence interval)

5.3. Association between diet types and academic achievement

Table 5 shows the results of logistic regression analysis using self-reported academic achievement as the dependent variable. The association between study achievement and diet types was not significant throughout the models. This result is in line with the chi-square test result that the association between diet types and academic achievement was not significant (Table 2). However, some association with other factors were observed. Female students had lower odds of being less successful than they had expected compared with male students through the whole models after socio-demographic factors were included in Model 2. Compare with students from the academic university, university of applied sciences students showed lower odds of being less successful than their expectation (OR [95% CI]: .75[.59–.96], $p<0.05$, in Model 6). The more physically active students were, the lower odds of being less successful than they had expected (OR [95% CI]: .90[.83–.98], $p<0.05$, in Model 6). In contrast, those who drank alcohol had higher odds of being less successful than non-drinker (OR [95% CI]: .90[.83–.98], $p<0.05$, in Model 6), and students who had a higher BMI score showed more likely to have higher odds ratios to be a less successful academic achievement. There was a geographical difference that compared to students in the Helsinki region, students in northern and eastern Finland showed higher odds of being less successful than they had expected. Older students showed higher odds of being less successful than they had expected, but the statistical significance of age was changed after adjusting for enrollment and the right field of study. Students who registered 3-6 years and over 6 years showed higher odds of being less successful than students who registered under 3 years (OR [95% CI]: 1.43[1.1–1.85], $p<0.01$ and OR [95% CI]: 2.74[1.56–4.82], $p<0.001$, respectively). Besides, students who answered they had chosen the wrong field of study or not sure about their choice showed more likely to consider to be less successful than students who answered they had chosen the right field of study (OR [95% CI]: 3.42[2.72–4.3], $p<0.001$).

Table 5. The association of diet types with academic achievement (0 = successful, 1 = less successful)

Type of diet	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Omnivorous	1	1	1	1	1	1
Semi-vegetarian(í)	.1.02(.67-1.53)	1.10(.73-1.67)	1.07(.69-1.63)	1.17(.75-1.82)	1.19(.76-1.86)	1.09(.67-1.69)
Vegetarian(ñ)	1.00(.69-1.44)	1.05(.72-1.53)	1.20(.82-1.76)	1.21(.82-1.78)	1.23(.83-1.81)	1.25(.83-1.87)
Vegan(ÿ)	1.43(.73-2.80)	1.60(.85-3.15)	1.90(.96-3.77)	1.83(.92-3.66)	1.83(.91-3.65)	1.79(.88-3.66)
Age		1.15(1.05-1.25)**	1.17(1.07-1.28)**	1.13(1.03-1.24)**	1.13(1.04-1.24)**	1.09(.98-1.20)
Male		1	1	1	1	1
Female		.65(.53-.81)***	.75(.60-.95)*	.74(.59-.93)*	.72(.57-.91)**	.72(.56-.91)**
Helsinki-Uusimaa		1	1	1	1	1
Southern Finland		1.20(.87-1.65)	1.17(.85-1.61)	1.14(.83-1.58)	1.15(.83-1.59)	1.12(.80-1.57)
Western Finland		1.15(.87-1.52)	1.12(.85-1.48)	1.09(.82-1.44)	1.09(.82-1.45)	1.01(.76-1.36)
Northern and Eastern Finland		1.41(1.06-1.87)*	1.37(1.03-1.84)*	1.40(1.04-1.88)*	1.40(1.05-1.88)*	1.45(1.07-1.96)*
University		1	1	1	1	1
University of applied sciences		.82(.66-1.03)	.78(.62-98)*	.72(.57-.91)**	.72(.57-.91)**	.75(.59-.96)*
Wholegrains			.97(.92-1.02)	.98(.93-1.03)	.98(.93-1.03)	1.00(.94-1.05)
Vegetables			.92(.86-.98)**	.92(.86-.99)*	.92(.86-.98)*	.93(.87-1.0)
Fruits			.94(.89-.99)*	.97(.92-1.03)	.97(.92-1.03)	.96(.90-1.01)
Physical				.88(.81-.96)**	.89(.81-.96)**	.90(.83-.98)*
Non-smoker				1	1	1
Smoke				1.12(.84-1.50)	1.13(.84-1.51)	1.09(.80-1.47)
Non-drinker				1	1	1
Drinker				1.42(1.00-2.01)	1.40(.99-1.98)	1.85(1.28-2.69)**
BMI				1.06(1.03-1.10)***	1.06(1.03-1.09)***	1.07(1.04-1.10)***
Disease					1.11(.97-1.27)	1.11(.97-1.28)
Enrolment period: under 3 years						1
Enrolment period: 3-6 years						1.43(1.1-1.85)**
Enrolment period: over 6 years						2.74(1.56-4.82)***
Right						1
No right						3.42(2.72-4.3)***

(í) not eating only meat; (ñ) not eating meat and poultry; (ÿ) not eating meat, poultry, fish, and dairies; Model 1: diet type; Model 2: Model 1 + age, sex, location, and institution; Model 3: Model 2 + whole grains, vegetables, and fruits consumption; Model 4: Model 3 + smoking, alcohol, BMI and physical activity; Model 5: Model 4 + disease conditions; Model 6: Model 5 + enrollment and right field of study. n = 2205 (i.e., participants with no missing data for the variables included in the models) *p<0.05, **p<0.01, ***p<0.001 Odds-Ratios (95% confidence interval)

There were associations between academic achievement and some food items. Vegetables and fruits intake showed associations with academic achievement (OR [95% CI]: .92[.86–.98], p<0.01 and OR [95% CI]: .94[.89–.99], p<0.05 in Model 3, respectively). However, the statistical significance was no longer exist for fruits after adjustment for healthy behaviour and BMI. The statistical significance of vegetable changed after adjustment for enrollment and the right field of study. Therefore, further exploratory logistic regression between the food groups and the academic achievement was attempted.

The results are shown in Table 6. The analysis shows that the more fish and vegetable intake, the more tendency of successful in perceived academic achievement (OR [95% CI]: .90[.83–.98], p<0.05 and OR [95% CI]: .92[.87–.99], p<0.05, respectively). While students were more likely to think that the more sweets they consumed, the less successful they expected (OR [95% CI]: 1.09 [1.03–1.16], p<0.05). This trend remained the same, except for vegetable consumption when adjusted for confounding factors such as demographic, health behaviours, BMI, disease conditions, enrollment, and right field of study.

Table 6. The association of food groups with academic achievement (0= successful, 1= less successful)

Food Groups	Academic achievement					
	Model 1			Model 2		
	OR	95% CI		OR	95% CI	
Whole grains	.96	.91	1.01	.98	.93	1.04
Fish	.90*	.83	.98	.88**	.80	.96
Meat	1.00	.95	1.07	.99	.92	1.05
Poultry	.98	.92	1.05	.98	.92	1.06
Dairy	.96	.92	1.01	.97	.92	1.02
Vegetable	.92*	.87	.99	.95	.88	1.01
Fruits	.95	.90	1.01	.97	.91	1.04
Juice	1.01	.96	1.06	1.01	.96	1.06
Soft Drinks	1.00	.93	1.08	.96	.89	1.05
Sweets	1.09**	1.03	1.16	1.08*	1.01	1.15

Model 1: food groups, Model 2: Model 1 + age, sex, location, institution, smoking, alcohol consumption, physical activity, BMI, disease conditions, enrollment, and right field of study. *n* = 2177 (i.e., participants with no missing data for the variables included in model) *p<0.05, **p<0.01, ***p<0.001 Odds-Ratios (95% confidence interval)

6. DISCUSSION

The present cross-sectional study aimed to investigate whether plant-based diets are associated with mental health status, academic achievement among Finnish higher education students. The results demonstrate that students who follow a vegetarian diet were more likely to have vulnerable mental health conditions in both clinically diagnosed mental disorders and minor psychiatric disorders status than those who follow an omnivorous diet. However, there was no statistically significant association between diet types and academic achievement. Nevertheless, a positive relationship between fish consumption and academic achievement and a negative relationship between sweets consumption and academic achievement have been observed.

6.1. Diet types and mental disorders

Both diagnosed mental disorders (including depression and anxiety) and minor psychiatric disorders screened by GHQ-12 show an association only with the vegetarian diet group among other types of plant-based diet groups. These results partly echo other studies that vegetarian dieters showed adverse mental health than non-vegetarian dieters among university populations (Nezlek, Forestell, & Newman 2018; Forestell & Nezlek 2018; Baines et al. 2007; Baş, Karabudak, & Kiziltan 2005; Lavallee et al. 2019). As stated earlier, the definition of plant-based diets has been inconsistent. In the present study, based on previous literature and regarded on the questions from the IDQ, the diet types were divided according to restrictions on certain food items: vegan who abstain all the animal-based foods; vegetarian who do not consume meat and poultry; semi-vegetarian who only exclude red meat and processed meat among animal-based food; omnivore who have no restrictions on their eating. The proportion of vegan in the total sample was 2.2%, and vegetarian and semi-vegetarian were 9.3% and 9.6%, respectively. The remaining 78.9% were omnivore. The vegetarian and vegan population ratio in this study was higher than the other Finnish population-based studies (vegan 1.9% and vegetarian 4.2% - Jallinoja, 2020; vegetarian 3.3% - Vinnari et al., 2009). It may be due to the different definition of plant-based diets (Dobersek et al., 2020), the way it was reported on the diet followed (Vinnari et al., 2009), or the differences in population characteristics (Iguacel et al., 2020). The majority of sample in the present study were under 30 years old, and female respondents outnumbered male respondents (65.4% of female and 34.6% of male among total respondents), which are common features of the vegan and

vegetarian populations (Vinnari et al., 2009; Baines et al., 2007). The different characteristics of the semi-vegetarian group in this thesis might influence the association of diet types with diagnosed mental disorders since there was a significant association between semi-vegetarian and diagnosed mental disorders that no longer observed after adjustment for socio-demographic factors. While almost half of the semi-vegetarians were studying at universities of applied sciences (48.5%), both vegan and vegetarian dieters were predominantly studying at the academic universities (71.6% and 73.3%, respectively). The semi-vegetarian group had better health-related behaviour, except for physical activities. For example, the rate of alcoholic beverage drinkers (38.29%) and smokers (10.80%) were surprisingly lower than any other diet types. These results contrasted with the findings from a study of young Australian (Baines et al., 2007).

Here are several possible mechanisms on the association between the vegetarian diet and mental health state. In terms of nutrition science perspective, if there were more foods to restrict, people were more likely to experience specific nutrition deficiency, and it might be related to general physical well-being according to such disease driven by vitamin D, vitamin B12, folic acid, iron, and zinc deficiency (Mozaffari-Khosravi et al., 2013; Vulser et al., 2016). For example, n-3 fatty acids have been suggested as a benefit on brain function, and its lack of intake was associated with mental disorders (Perica & Delaš, 2011). Besides, Vulser et al. (2016) suggested that depressive people showed more prevalence of anaemia caused by deficiencies in vitamin B12, folic acid, iron, and zinc. Ruusunen (2013) discovered that lower folic acid consumption among middle-aged men in eastern Finland was linked to depression. Elorinne et al. (2016) found that low vitamin B12 and vitamin D intake among Finnish plant-based dieters even though they used the dietary supplements. Since B vitamins and vitamin D were a positive association with cognitive functions (Scarmeas et al., 2018), it is possible to associate with mental health status. Considering the result from this thesis that the vegetarian group seem to be more likely to have mental disorders than the omnivore group, it can be assumed that animal-based foods may play some role in the association with mental health state among Finnish higher education students. However, the ability to interpret the nutrients related mechanism has been limited in the present study, given that the small sample size of plant-based diet groups and precise level of food intake among the diet groups were unknown.

Other possible mechanisms of present results are that individual values or socio-cultural environments could play an important role in addition to the nutritional factors expected from avoiding or eating meat. Since daily food consumption practices are inseparable from the culture, social, and individual or psychological characteristics of humans, as Mäkelä & Niva (2016) pointed out, the complexities involved in food consumption and eating in everyday life must first be known. Therefore, considering these complex interactions, focusing only on a single unit of nutrients or foods may provide an insufficient explanation of the relationship between diet and mental health (Jacka et al., 2010). It is not easy to find one specific factor related to mental health because various factors are complexly shaped human behaviour. As Plante et al. (2019) mentioned, one's dietary choice is a combination of internal and external factors (such as motivations and dietary restrictions) under the social and cultural context.

From a psychological perspective, restrictive attitude may associate with depressive symptoms because restriction per se gives distress. The research conducted by Matta and colleagues (2018) suggested that limiting food items could be more associated with depressive symptoms. They found the link between depression and the number of restricted food items. The greater number of excluded food items, the higher odds of being depressed, regardless of the types of food items (Matta et al., 2018). According to Rappoport (2003), people can be depressed when they break their diet rule, and they tend to break more when they are depressed. In other words, when there are more food items to restrict, the likelihood of violating their own set goal is increased, and people are more likely to become depressed by breaking their own rules. It eventually leads to a vicious cycle of regulatory violations and depression, which can be assumed to have a reliable association between food restriction and depression, regardless of the type of food itself. Besides, there may be a link between vegetarianism and perfectionism (Michalak, Zhang & Jacobi, 2012; Matta et al., 2018). According to Egan, Wade, and Shafran (2011), perfectionism can increase or maintain eating disorder, anxiety, and depression, as well as impede the successful treatment of mental disorders. Therefore, perfectionist or restrict many of food items are more likely to suffer from mental disorders. However, vegans, who are known to be more restrictive than those on other plant-based dieters, does not seem to apply to this assumption. Beezhold et al. (2015) suggested that reducing animal-based food were associated with a better mood state, and vegan showed less stress and anxiety and a healthier lifestyle than omnivores. The results of the present thesis also showed no significant association between vegan diets and mental disorders. However, it should

be noted here the interpretation of statistical significance may be limited due to the small sample size of vegan. Vegans may be triggered to follow their diet by other factors that are less associated with depression. It can be assumed that other potential mechanisms such as motivation to be healthy, the sense of belonging among vegan society may help maintain their mental health status. Since the vegan community have more engaged with each other under the same movement toward their aims (Wrenn, 2019), in other words, vegans might feel more sense of belonging as being vegan than other vegetarian dieters. These community activities may also provide better knowledge of preparing food to maintain nutritional balance while excluding animal-based foods on their diet.

As mentioned previously, plant-based dieters have various motivations for choosing their diet, such as health, ethical, environmental, and religion (Ruby, 2012; De Backer & Hudders, 2014; Le & Sabaté, 2014; Kalte, 2020). These motivations could make a difference between diet choices and the association with mental well-being (Michalak, Zhang & Jacobi, 2012; Matta et al., 2018). This tendency might suggest possible explanations of why some plant-based dieters showed contradicting results on the association with mental health conditions despite the high probability of essential nutrient deficiencies. For instance, health-motivated plant-based dieters were more interested in health and want to follow healthier behaviour (Mozaffarian, 2016). Those people were doing "healthy" activities than those who are omnivores, such as exercising more, eating more fruits and vegetables, smoking less cigarette, and drinking less alcohol (Waldmann et al., 2003; Beezhold et al., 2015; Sprake et al., 2018). Besides, healthy lifestyles could prevent or reduce depressed mood (Coen et al., 2006). Ethical-motivated plant-based dieters had a prosocial attitude (Rosenfeld, 2019) that more sympathised to consider sustainability, human inequality, and animal welfare (Beadsworth & Keil, 1992). They formed their motivations within a philosophical, ideological or spiritual framework (Fox & Wald, 2008a), and these attitudes may help control mental stress. Beezhold, Johnston and Daigle (2010) conducted their study on believers at Seventh Day Adventist. The study showed that participants who follow vegetarian diets were less anxious and stressed than those who do not follow vegetarian diets. Although both vegetarian and omnivore participants were homogeneous in terms of lifestyle characteristics, vegetarians showed more physically active and less BMI scores (Beezhold, Johnston & Daigle, 2010). It can be interpreted that ethically motivated vegetarians showed more adherence to their dietary restriction than other motivated vegetarians (Rosenfeld, 2019), religious people are more familiar to fulfil such

obligations. With this regard, vegetarian who supported by the same religious vegetarian felt more sense of belonging, and this belongingness may help people to prevent depression (Michalak, Zhang & Jacobi, 2012; Matta et al., 2018).

Along with the motives for taking plant-based diets, another possible mechanism could explain the link between plant-based diets and mental disorders. The temporal relationship between the timing of the onset of mental disorders and the timing of choosing plant-based diets can be a potential factor (Michalak et al., 2012). On average, people with a history of mental disorders showed that the age of starting the meat-free diet (30.58 years old) was older than the age at which mental disorders began (24.69 years old), and they showed more health-oriented behaviour (Michalak et al., 2012). People who have been diagnosed with mental disorders may more opt for plant-based diets because they believe that plant-based diets will help them overcome mental illness and stabilise themselves. Thus, it can be speculated that there is a greater prevalence of mental disorders among people on plant-based diets than omnivores. In similar line with this assumption, the prevalence of diagnosed mental disorders showed more among plant-based diet groups than omnivores diet group in this thesis (vegan = 22.0%; vegetarian = 23%; semi-vegetarian = 19.4%; and omnivore = 10.3%; $p<.001$) and the prevalence of minor psychiatric disorders screened by GHQ-12 scores observed higher among plant-based diet groups excluding semi-vegetarian (GHQ-12: vegan = 33.9%; vegetarian = 36.9%; semi-vegetarian = 24.6%; and omnivore = 29.3%; $p<.012$). The statistically significant odds ratio was observed only in the vegetarian diet group among other plant-based diets. Plant-based dieters tend to move back and forth between more stringent and less stringent restrictions depending on their motivation, social environment, and nutrition knowledge (Beardsworth & Keil, 1992). Also, people have tended to label themselves as a vegetarian to display information about their social identity even though they did not follow as strictly as other vegetarians (Rosenfeld, Rothgerber & Tomiyama., 2020). Considering the characteristics mentioned above, people who have been diagnosed with mental disorders may be more distributed in the vegetarian group. Although the present thesis cannot observe temporal associations due to the limitation of cross-sectional data, the result from this thesis may suggest that participants' current diets are associated with their current mental health state since GHQ-12 assesses current mental health conditions (Anjara et al., 2020).

In this thesis, the two different degrees of the mental health state were used to investigate the association between mental disorders and the diet types so as to reduce the intrinsic limitation of the self-reporting bias as well as to examine whether the association can be observed at different levels of mental health status. Mental health conditions were investigated in two aspects, (1) clinically diagnosed mental disorders, which indicated the severe condition of mental health status (2) minor psychiatric disorder screened by GHQ-12 scores. It allowed a comprehensive analysis of mental disorder prevalence trends so that the more reliable results were able to be extracted. The potential bias from the self-report data can be reduced in this study, considering the previous studies claimed that the self-reported medical conditions were reasonably accurate (Martin, Leff, Calonge, Garrett, & Nelson, 2000; Snow et al., 2005), and GHQ-12 is one of the most used self-reporting measurements for evaluating psychological disorders (Anjara et al., 2020; Mäkikangas et al., 2006). The prevalence of having mental disorders shown higher in screened with GHQ-12 scores than self-reported diagnosed mental disorder status among all the types of diets in this study. The association with mental health status in this both degrees were observed in the vegetarian diet group, although there were slightly different features among the association between other potential variables. However, the overall association looked similar. For example, female, smoker, and higher BMI students showed statistically significant higher odds of being both clinically diagnosed with mental disorders and minor psychiatric disorders. These potential confounding factors did not change the association between a vegetarian diet and both degrees of mental health status. Therefore, using both measurements to examine the association between mental health status and diet types gives strength to the results of this thesis.

6.2. Diet types, food groups, and academic achievement

Although there is increasing attention to the impact of dietary patterns on academic achievement among undergraduate populations (Burrows et al., 2017), there have been few studies observed which covered the association between diet types, including meat-free diets and academic achievement. In this study, the aim was to find the association between diet types, especially plant-based diets, and academic achievement. There was no statistically significant association between plant-based diet types and academic achievement. However, the higher the fish consumed, the less likely the students considered their academic achievement was being less successful than their

expectation, and the more they had sweets, the more likely they thought their academic achievement was being less successful than their expectation.

The benefits of fish consumption on academic achievement were observed among younger population studies. For example, Swedish adolescents showed the more fish consumption was linked with higher grades in their studies, and the association remained after adjusting for potential confounding factors (Kim et al., 2010). Dutch adolescents also showed better performance on their cognitive ability and academic achievement with a higher intake of fish (De Groot, R. H. M, Ouwehand, & Jolles, 2012). One of the possible hypotheses of the link between diet and academic achievement is that various nutrients (e.g., B vitamins, vitamin D, and n-3 fatty acids) and foods (e.g., fish, vegetables, and fruit) have the potential benefit on cognitive function (Scarmeas et al., 2018; Kivipelto et al., 2018). Besides, a lower intake of energy-dense foods (e.g., junk food, sweets, and sugar-sweetened beverages) showed higher academic achievement (Burrows, Goldman, Pursey, & Lim, 2017). The associations between academic achievement and healthy diet pattern have been observed in several studies regardless of the population's age (Burrows, Goldman, Pursey, & Lim, 2017; Burrows et al., 2017; Whatnall et al., 2019). Since having breakfast or regular mealtimes, and overall better quality of the diet can lead to more diverse nutrients intake such as vitamins, folate, and fibre (Deshmukh-Taskar et al., 2010; Barr et al., 2013), the positive association between diet and academic achievement among students who consume regular meals, including breakfast consumption and higher consumption of fruits and vegetables can be expected.

Along with these associations, an association with other lifestyle factors was observed in this thesis. For example, female and physically active students showed lower odds ratio to be less successful than they had expected, and those who drank alcohol had higher odds of being less successful than non-drinkers. Furthermore, students who enrolled in more academic years (e.g., 3-6 years and over 6 years) showed higher odds of being less successful than students who enrolled under 3years of the academic year. These results are in a similar line with previous studies that suggested various factors influence academic achievement, such as drinking habit, eating habits, gender, and mental health state (Singleton & Wolfson, 2009; Trockel et al., 2000; Reuter et al., 2020. Hysenbegasi et al., 2005). High academic achievement for future success such as career, income, and quality of life is important for students, along with other unique characteristics of

university life. Students face various changes starting their life at the university, and this environment changes influence student's lifestyle as well as eating behaviour (Deliens et al., 2014).

In this sense, plant-based diets might have two-side of the same coin. On the one hand, plant-based diets are known as low in saturated fat and cholesterol consumption and high in the consumption of fruits, vegetables, nuts, and whole grains, which increase fibre and phytochemicals intake (Lea & Worsley, 2003a; Craig & Mangels, 2009; Beezhold et al., 2015). There is an association between better academic achievement among undergraduate students and higher diet quality, such as fruits and vegetables (Whatnall et al., 2019; Peltzer et al., 2015). Therefore, appropriately planned plant-based diets might provide better academic achievement since it is nutritionally appropriate (Craig & Mangels, 2009). Furthermore, plant-based dieters are known as following healthier lifestyle than those who are omnivores, such as exercising more, eating more fruits and vegetables, smoking less cigarette, and drinking less alcohol (Waldmann et al., 2003; Beezhold et al., 2015; Sprake et al., 2018). It may support to fulfil higher academic achievement. On the other hand, an association with mental disorders, including depression, may increase the likelihood of achieving lower academic achievement (Hysenbegasi, 2005; Heiligenstein, 1996; Iarovici 2014, p.141). Since there is an increasing body of studies that vegetarian dieters showed adverse mental health status than non-vegetarian dieters among university populations (Nezlek, Forestell, & Newman 2018; Forestell & Nezlek 2018; Baines et al. 2007; Baş, Karabudak, & Kiziltan 2005; Lavallee et al. 2019), plant-based diets might indicate lower academic achievement among the university students.

The data in this thesis shows that although there was the association between plant-based diets and mental disorder, there was no statistically significant association supporting the relationship between diet types and academic achievements. It might be because both measurements on diet types and academic achievement were self-reported, thus there might have a potential bias. However, the study by Vinnari et al. (2009) suggested diet type identification by food frequency questionnaire (FFQ) was considered more accurate than relying on simple questions based on self-identification, although there remains some bias due to self-report FFQ. In contrast, since most of the academic achievement studies among undergraduates were used grade point average (GPA) of academic achievement (Burrows et al., 2017), It would have been beneficial to conduct the present study through validated indicators. Besides, in this thesis, only the frequency of food intake was

captured, and information on the type of fish (lean or fatty fish) or portion size was limited, hence, there is a limit to establishing the association by specific nutrients. Nevertheless, more fish consumption was observed to be associated with better perceived academic achievement, and more sweets consumption indicated lower perceived academic achievement among Finnish higher education students.

6.3. Strengths and Limitations of this study

Although there is growing interest in plant-based diets and the mental and physical health aspects of following these diets, there is not much research in higher education populations to examine mental health and study achievement by diet types. This thesis has shed light on previous results showing the association between mental health and plant-based diets (Baines et al. 2007; Forestell & Nezlek, 2018; Lindeman, 2002) and has sought to shed new light on the association between academic achievement and plant-based diets. One of the strengths of this study is that the study focused on undergraduate students by using data from the Student Health Survey 2016, which is appropriate to examine the Finnish higher education population. The nationwide samples consisted of students from academic universities and universities of applied sciences in Finland. Moreover, this thesis used not only the General Health Questionnaire-12 (GHQ-12) but also used the clinically diagnosed mental disorders to examine the association between mental health and diet types. In addition, there were further considerations on other possible confounding factors to find associations in this thesis. For example, the role of disease conditions, BMI, and health-related behaviour (physical activity, smoking, and alcohol consumption) were considered. Finally, using the food frequency questions to identify diet types in this thesis is considered more accurate than using a simple question to identify diet types based on self-identification (Vinnari et al., 2009).

Since the study was limited to cross-sectional analyses, it was not possible to draw the likelihood of causality, and it was not known the temporal ordering between the timing of the onset of mental disorders and the timing of choosing the plant-based diet. Second, there were short comes of dietary data. The nutrition composition of each diet group was unknown because the food frequency questions did not identify the actual intake of each food items. In addition, there was no question about the consumption of eggs and an option to ask to exclude the intake of food items completely. Although the answer options were from 0 (less often than once a week) to 7 (every

day), which could almost indicate zero consumption of such food items, there was no ‘never use’ option in the questionnaire. Therefore, there is still a possibility of not ruling out the possible consumption of limited food items, even though participants were classified as vegan, vegetarian, and semi-vegetarian.

Further limitations come from the fact that the study was self-reported. For example, the academic achievement measured by a question of subjective perception (i.e., "If you think about your own goals, how successful do you think you have been in your studies?") could introduce bias. It would be ideal for analysing through objective indicators such as GPA since it mainly used in similar studies, and it is a reliable measurement to compare academic achievement (Burrow et al., 2017). In addition, socio-economic status (SES), such as income or household composition, was not considered. SES might influence students’ food intake (Lallukka et al., 2007), depression (Freeman et al., 2016), and academic achievement (Karvonen et al., 2018). Lastly, although the sample was considerably large and good representativeness of Finnish academic universities and university of applied science students, the response rate was relatively low (31%), and the proportion of respondents was 34.5% and 65.5% for men and women, respectively (Kunttu et al., 2017). Even though the University Student Health Survey 2016 showed a lower response rate than previous surveys, it is common for web surveys to receive 6 to 15 per cent lower responses than other survey methods (Van Mol, 2017). Also, low response rates were seen in surveys conducted on the student population (Kunttu et al., 2017). A study by Hendra & Hill. (2019) showed that the non-response bias in a higher-response survey was similar to that of a much lower-response survey, therefore, even low-response surveys can achieve results as valid as high-response surveys. Furthermore, according to Kunttu et al. (2017), no significant noticeable changes have been observed when comparing the findings from the University Student Health Survey 2016 with previous student health surveys. It can indicate that there were fewer composition changes on the respondents. They also conducted an analysis among male non-respondent students, which showed that no accumulation of health problems was seen in the non-respondents (Kunttu et al., 2017). However, considering the burden of answering a lengthy questionnaire and underrepresented male population, it is hard to rule out the possibility of bias in the characteristics of respondents.

7. CONCLUSIONS

Plant-based diets have recently been inspiring a lot of academic interests due to the social and environmental problems that people have been faced all-over the world. Despite many advantages in following plant-based diets, whether plant-based diets are healthier in terms of mental health has been raised a question. Besides, university students are more likely to become plant-based dieters, given that those who young, living in urban areas, and highly educated people are more likely to be interested in plant-based diets. Research on this population group is considered essential because the unique characteristics of the university period are important for students in establishing a healthy lifestyle and improving their future quality of life.

The findings in this study highlight that there is a significant association between the vegetarian diet and the prevalence of mental disorders among Finnish higher education students. Despite healthy eating habits have been associated with better academic outcomes, and mental disorders have been shown an adverse effect on academic achievement, the results in this study showed that there was no significant relationship between plant-based diets and academic achievement. However, specific food consumption and lifestyle factors were associated with academic achievement. These results suggest that academic achievement could be more associated with characteristics of lifestyle in general rather than particular types of diets. It should be noted here that both academic achievement and dietary intake were self-reported, which should be considered when interpreting findings. In addition, it has been almost impossible to investigate nutrition value on each diet type in this study, therefore, the nutritional aspects (e.g., n-3 fatty acid, vitamin B-12, and vitamin D) on mental health remained unclear. For a better understanding of the relationship between dietary choices, mental health status, and academic achievement, it would be beneficial to apply more various classifications and measures on diet types and academic achievement, as well as consider longitudinal data to examine how the relationship between university students' diet types and mental health status vary over time. Future studies should include larger samples of participants with different plant-based diet types, considering the temporal relationship and potential confounding factors (e.g., socio-economic status, motivation).

It is important to support university students in making healthy food choices and enhancing their quality of diet, considering the unique character of the university period, which has a huge influence on establishing lifelong behaviour. The results of this study suggest that vegetarian

students should carefully monitor their mental health status. The results can also suggest a direction for choosing healthy food and enhancing dietary quality to increase students' academic achievement. In sum, this study could support interventions to improve higher education students' lifestyle behaviour from a public health perspective.

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9. APPENDIX

Appendix 1. General Health Questionnaire-12 (GHQ-12), Positive items (Questions 1-6) and Negative items (Questions 7-12), as used in FSHS 2016

		Rather more than usual	Same as usual	Less than usual	Much less than usual
1	Have you recently been able to concentrate on whatever you are doing?	1	2	3	4
2	Have you recently felt that you are playing a useful part in things?	1	2	3	4
3	Have you recently felt capable of making decisions about things?	1	2	3	4
4	Have you recently been able to enjoy your normal day to day activities?	1	2	3	4
5	Have you recently been able to face up to tour problems?	1	2	3	4
6	Have you recently been feeling reasonably happy, all things considered?	1	2	3	4
		Not at all	Same as usual	More than usual	Much more than usual
7	Have you recently lost much sleep over worry?	1	2	3	4
8	Have you recently felt constantly under strain?	1	2	3	4
9	Have you recently felt you couldn't overcome your difficulties?	1	2	3	4
10	Have you recently been feeling unhappy and depressed?	1	2	3	4
11	Have you recently been losing confidence in yourself?	1	2	3	4
12	Have you recently been thinking of yourself as a worthless person?	1	2	3	4